

## MILITARY SPECIFICATION

### SEMICONDUCTOR DEVICE, TRANSISTOR, NPN, GERMANIUM, SWITCHING

#### TYPE 2N388

*This specification is mandatory for use by all Departments and Agencies of the Department of Defense.*

#### 1. SCOPE

1.1 Scope. This specification covers the detail requirements for a NPN, germanium, low-power switching transistor.

1.2 Physical dimensions. See figure 1 (TO-5).

1.3 Maximum ratings.

PT 1/	VCBO	VCER	VEBO	IC	T <sub>stg</sub>
<i>mW</i>	<i>Vdc</i>	<i>Vdc</i>	<i>Vdc</i>	<i>mAdc</i>	<i>°C</i>
150	25	20	15	200	-65 to +100

1/ Derate linearly 2 mW/°C for T<sub>A</sub> > 25° C.

1.4 Primary electrical characteristics.

Limits	C <sub>obo</sub>  V <sub>CB</sub> = 6 Vdc I <sub>E</sub> = 0 100 kHz ≤ f ≤ 1 MHz	f <sub>hfb</sub>  V <sub>CB</sub> = 6 Vdc I <sub>E</sub> = 1 mAdc	h <sub>FE</sub>  V <sub>CE</sub> = 0.5 Vdc I <sub>C</sub> = 30 mAdc	t <sub>on</sub>	t <sub>s</sub>	t <sub>f</sub>
	<i>pf</i>	<i>MHz</i>		<i>μsec</i>	<i>μsec</i>	<i>μsec</i>
Min	---	5	60	---	---	---
Max	20	60	180	1	0.7	0.7

#### 2. APPLICABLE DOCUMENTS

2.1 The following documents, of the issue in effect on date of invitation for bids or request for proposal, form a part of the specification to the extent specified herein.

## **SPECIFICATION**

### **MILITARY**

MIL-S-19500 - Semiconductor Devices, General Specification for.

## **STANDARD**

### **MILITARY**

MIL-STD-750 - Test Methods for Semiconductor Devices.

(Copies of specifications, standards, drawings, and publications required by suppliers in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.

## **3. REQUIREMENTS**

**3.1 General.** Requirements shall be in accordance with MIL-S-19500, and as specified herein.

**3.2 Abbreviations, symbols, and definitions.** The abbreviations, symbols, and definitions used herein are defined in MIL-S-19500.

**3.3 Design, construction, and physical dimensions.** Transistors shall be of the design, construction, and physical dimensions shown on figure 1.

**3.3.1 Terminal-lead length.** Terminal-lead length(s) other than that specified in figure 1 may be furnished when so stipulated under contract or order (see 6.2) where the devices covered herein are required directly for particular equipment-circuit installation or for automatic-assembly-technique programs. Where other lead lengths are required and provided, it shall not be construed as adversely affecting the qualified-product status of the device, or applicable JAN marking.

**3.4 Performance characteristics.** Performance characteristics shall be as specified in tables I, II, and III.

**3.5 Marking.** The following marking specified in MIL-S-19500 may be omitted from the body of the transistor at the option of the manufacturer:

- (a) Country of origin.
- (b) Manufacturer's identification.

## **4. QUALITY ASSURANCE PROVISIONS**

**4.1 Sampling and inspection.** Sampling and inspection shall be in accordance with MIL-S-19500, and as specified herein.

**4.2 Qualification inspection.** Qualification inspection shall consist of the examinations and tests specified in tables I, II, and III.

**4.3 Quality conformance inspection.** Quality conformance inspection shall consist of group A, B, and C inspections.

**4.3.1 Group A inspection.** Group A inspection shall consist of the examinations and tests specified in table I.

**4.3.2 Group B inspection.** Group B inspection shall consist of the examinations and tests specified in table II.

**4.3.3 Group C inspection.** Group C inspection shall consist of the examinations and tests specified in table III. This inspection shall be conducted on the initial lot and thereafter every 6 months during production.

**4.3.4 Group B and group C life-test samples.** Samples that have been subjected to group B, 340-hour life-test, may be continued on test to 1,000 hours in order to satisfy group C life-test requirements. These samples shall be predesignated, and shall remain subjected to the group C 1,000-hour acceptance evaluation after they have passed the group B, 340-hour acceptance criteria. The cumulative total of failures found during 340-hour test and during the subsequent interval up to 1,000 hours shall be computed for 1,000-hour acceptance criteria.

**4.4 Methods of examination and test.** Methods of examination and test shall be as specified in tables I, II, and III.

## 5. PREPARATION FOR DELIVERY

**5.1** See MIL-S-19500, section 5.

## 6. NOTES

**6.1 Notes.** The notes specified in MIL-S-19500 are applicable to this specification.

**6.2 Ordering data.** Procurement documents should specify the following: Terminal-lead length if other than specified in figure 1 (see 3.3.1).

**6.3 Changes from previous issue.** Asterisks are not used in this revision to identify changes with respect to the previous issue due to the extensiveness of the changes.

TABLE I. Group A inspection

Examination or test	MIL-STD-750		LTPD	Symbol	Limits		Unit
	Method	Details			Min	Max	
<i>Subgroup 1</i>			10				
Visual and mechanical examination	2071			---	---	---	---
<i>Subgroup 2</i>			5				
Breakdown voltage, collector to base	3001	Bias cond. D; $I_C = 10 \mu\text{Ade}$		$BV_{CBO}$	25	---	Vdc
Breakdown voltage, emitter to base	3026	Bias cond. D; $I_E = 10 \mu\text{Ade}$		$BV_{EBO}$	15	---	Vdc
Breakdown voltage, collector to emitter	3011	Bias cond. B; $I_C = 50 \mu\text{Ade}$ ; $R_2 \approx 10 \text{ kohms}$		$BV_{CER}$	20	---	Vdc
Forward-current transfer ratio	3076	$V_{CE} = 0.75 \text{ Vdc}$ ; $I_C = 200 \text{ mAde}$		$h_{FE}$	30	---	---
Forward-current transfer ratio	3076	$V_{CE} = 0.5 \text{ Vdc}$ ; $I_C = 30 \text{ mAde}$		$h_{FE}$	60	180	---
Base-emitter voltage (saturated)	3066	Test cond. A; $I_C = 200 \text{ mAde}$ ; $I_B = 10 \text{ mAde}$		$V_{BE(sat)}$	---	1.5	Vdc
Base-emitter voltage (saturated)	3066	Test cond. A; $I_C = 100 \text{ mAde}$ ; $I_B = 4 \text{ mAde}$		$V_{BE(sat)}$	---	0.8	Vdc
<i>Subgroup 3</i>			5				
Switching parameters:							
Turn-on time	3251	Test cond. B (see figure 3)		$t_{on}$	---	1	$\mu\text{sec}$
Storage time	3251	Test cond. B (see figure 3)		$t_s$	---	0.7	$\mu\text{sec}$
Fall time	3251	Test cond. B (see figure 3)		$t_f$	---	0.7	$\mu\text{sec}$
<i>Subgroup 4</i>			10				
Emitter to base cutoff current	3061	Bias cond. D; $V_{EB} = 1 \text{ Vdc}$		$I_{EBO}$	---	5	$\mu\text{Ade}$
Collector to base cutoff current	3036	Bias cond. D; $V_{CB} = 1 \text{ Vdc}$		$I_{CBO}$	---	5	$\mu\text{Ade}$
Small-signal short-circuit forward-current transfer-ratio cutoff frequency	3301	$V_{CB} = 6 \text{ Vdc}$ ; $I_E = 1 \text{ mAde}$		$f_{hfb}$	5	60	MHz
Open circuit output capacitance	3236	$V_{CB} = 6 \text{ Vdc}$ ; $I_E = 0$ ; $100 \text{ kHz} \leq f \leq 1 \text{ MHz}$		$C_{obo}$	---	20	pF

TABLE II. Group B inspection

Examination or test	MIL-STD-750		LTPD	Symbol	Limits		Unit
	Method	Details			Min	Max	
<i>Subgroup 1</i>			20				
Physical dimensions	2066	(See figure 1)		---	---	---	---

TABLE II. Group B inspection - Continued

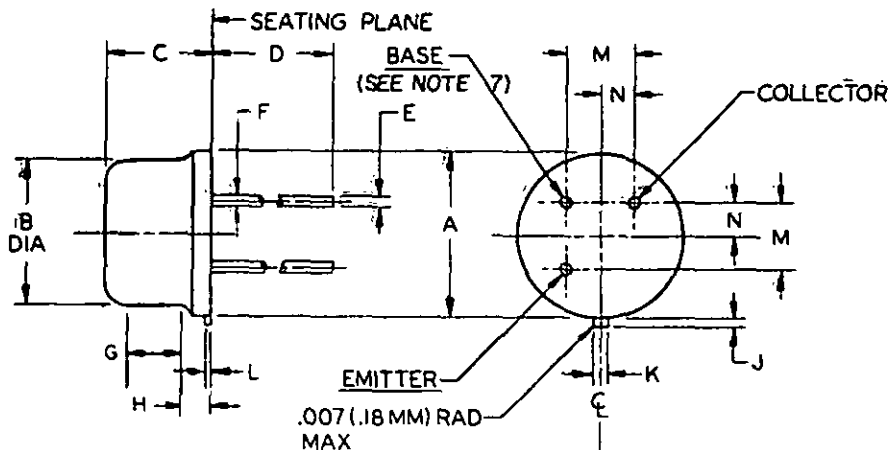
Examination or test	MIL-STD-750		LTPD	Symbol	Limits		Unit
	Method	Details			Min	Max	
<i>Subgroup 2</i>			10				
Solderability	2026			---	---	---	---
Thermal shock (temperature cycling)	1051	Test cond. B, except $T_{\max} = 100^{\circ} + 0^{\circ}, -5^{\circ}\text{C}; 1 \text{ cycle}$		---	---	---	---
Thermal shock (glass strain)	1056	Test cond. A; 1 cycle		---	---	---	---
Hermetic seal	1071	Test cond. G or H for fine leaks; test cond. A, C, D or F for gross leaks		---	---	$1 \times 10^{-7}$	atm cc/sec
Moisture resistance	1021			---	---	---	---
End points:							
Emitter to base cutoff current	3061	Bias cond. D; $V_{EB} = 15 \text{ Vdc}$		$I_{EBO}$	---	10	$\mu\text{A dc}$
Collector to base cutoff current	3036	Bias cond. D; $V_{CB} = 25 \text{ Vdc}$		$I_{CBO}$	---	10	$\mu\text{A dc}$
Forward-current transfer ratio	3076	$V_{CE} = 0.75 \text{ Vdc}; I_C = 200 \text{ mA dc}$		$h_{FE}$	30	---	---
<i>Subgroup 3</i>			10				
Shock	2016	Nonoperating; 500 G, 1 msec; 5 blows in each orientation: $X_1, Y_1, Y_2$ and $Z_1$		---	---	---	---
Vibration, variable frequency	2056			---	---	---	---
Constant acceleration	2006	10,000 G in each orientation: $X_1, Y_1, Y_2$ and $Z_1$		---	---	---	---
End points: (Same as subgroup 2)							
<i>Subgroup 4</i>			10				
Terminal strength (lead fatigue)	2036	Test cond. E		---	---	---	---
End points:							
Hermetic seal	1071	Test cond. G or H for fine leaks; test cond. A, C, D or F for gross leaks		---	---	$1 \times 10^{-7}$	atm cc/sec
<i>Subgroup 5</i>			20				
Salt atmosphere (corrosion)	1041			---	---	---	---
End points: (Same as subgroup 2)							

TABLE II. Group B inspection - Continued

Examination or test	MIL-STD-750		LTPD	Symbol	Limits		Unit
	Method	Details			Min	Max	
<b>Subgroup 6</b>			7				
High-temperature life (nonoperating)	1032	$T_{stg} = +100^{\circ}\text{C}$ ; time = 340 hours (see 4.3.4)		—	—	—	—
End points:							
Emitter to base cutoff current	3061	Bias cond. D; $V_{EB} = 15\text{ Vdc}$		$I_{EBO}$	—	15	$\mu\text{Ade}$
Collector to base cutoff current	3036	Bias cond. D; $V_{CB} = 25\text{ Vdc}$		$I_{CBO}$	—	20	$\mu\text{Ade}$
Forward-current transfer ratio	3076	$V_{CE} = 0.75\text{ Vdc}$ ; $I_C = 200\text{ mAde}$		$h_{FE}$	24	—	—
<b>Subgroup 7</b>			7				
Steady-state operation life	1027	$V_{CB} = 25\text{ Vdc}$ ; $P_T = 150\text{ mW}$ ; time = 340 hours (see 4.3.4)		—	—	—	—
End points: (Same as subgroup 6)							

TABLE III. Group C inspection

Examination or test	MIL-STD-750		LTPD	Symbol	Limits		Unit
	Method	Details			Min	Max	
<b>Subgroup 1</b>			$\lambda = 10$				
High-temperature life (nonoperating)	1031	$T_{stg} = +100^{\circ}\text{C}$ (see 4.3.4)		—	—	—	—
End points: (Same as subgroup 6 of group B)							
<b>Subgroup 2</b>			$\lambda = 10$				
Steady-state operation life	1026	$V_{CB} = 25\text{ Vdc}$ ; $P_T = 150\text{ mW}$ (see 4.3.4)		—	—	—	—
End points: (Same as subgroup 6 of group B)							

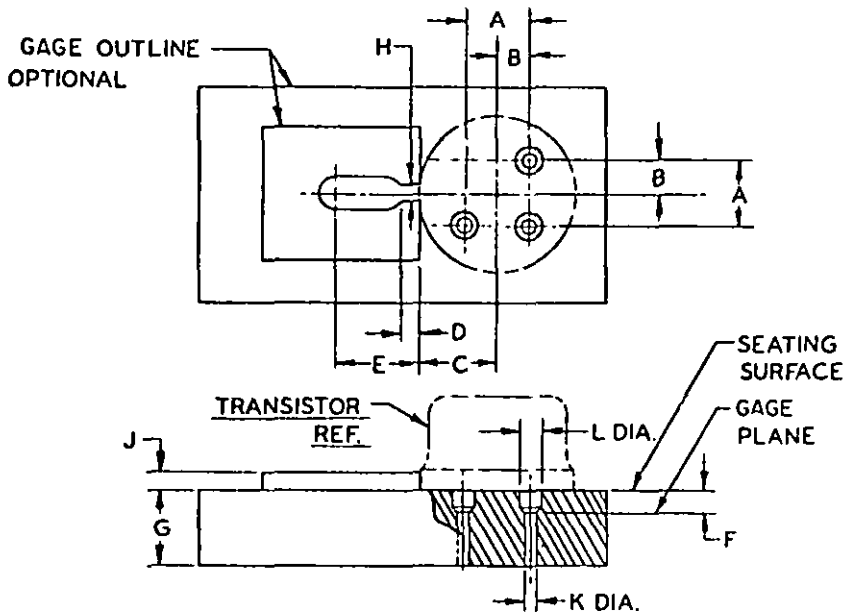


DIMENSIONS					NOTES
LTR	INCHES		MILLIMETERS		
	MIN	MAX	MIN	MAX	
A	.335	.370	8.51	9.40	--
B	.305	.335	7.75	8.51	--
C	.240	.260	6.10	6.60	--
D	1.500	1.750	38.10	44.45	9
E	.016	.021	.41	.53	2,9
F	.016	.019	.41	.48	3,9
G	.100	---	2.54	---	4
H	---	---	---	---	5
J	.029	.045	.74	1.14	8
K	.028	.034	.71	.86	--
L	.009	.125	.23	3.18	--
M	.1414 Nom		3.59 Nom		6
N	.0707 Nom		1.80 Nom		6

## NOTES:

1. Metric equivalents (to the nearest .01 mm) are given for general information only and are based upon 1 inch = 25.4 mm.
2. Measured in the zone beyond .250 (6.35 mm) from the seating plane.
3. Measured in the zone .050 (1.27 mm) and .250 (6.35 mm) from the seating plane.
4. Variations on dimension B in this zone shall not exceed .010 (.25 mm).
5. Outline in this zone is not controlled.
6. When measured in a gaging plane .054  $\pm$ .001, -.000 (1.37  $\pm$ .03, -.00 mm) below the seating plane of the transistor maximum diameter leads shall be within .007 (.18 mm) of their true location relative to a maximum width tab. Smaller diameter leads shall fall within the outline of the maximum diameter lead tolerance. Figure 2, preferred measured method.
7. The base shall be electrically connected to the case.
8. Measured from the maximum diameter of the actual device.
9. All 3 leads.

FIGURE 1. Physical dimensions of transistor type 2N388 (TO-5).



LTR	DIMENSIONS			
	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	.1409	.1419	3.58	3.60
B	.0702	.0712	1.78	1.81
C	.182	.199	4.62	5.05
D	.009	.011	.23	.28
E	.125 Nom		3.18 Nom	
F	.054	.055	1.37	1.40
G	.372	.378	9.45	9.60
H	.0350	.0355	.89	.90
J	.150 Nom		3.81 Nom	
K	.0325	.0335	.83	.85
L	.0595	.0605	1.51	1.54

NOTES:

1. The following gaging procedure shall be used: The use of a pin straightener prior to insertion in the gage is permissible. The device being measured shall be inserted until its seating plane is  $.125 \pm .010$  (3.18  $\pm$  .25 mm) from the seating surface of the gage. A spacer may be used to obtain the .125 (3.18 mm) distance from the gage seat prior to force application. A force of 8 oz  $\pm$  .05 oz shall then be applied parallel and symmetrical to the device's cylindrical axis. When examined visually after the force application (the force need not be removed) the seating plane of the device shall be seated against the gage.
2. The location of the tab locator, within the limits of dim C, will be determined by the tab and flange dimension of the device being checked.
3. Metric equivalents (to the nearest .01 mm) are given for general information only and are based upon 1 inch = 25.4 mm.

FIGURE 2. Gage for lead and tab location for transistor type 2N388.



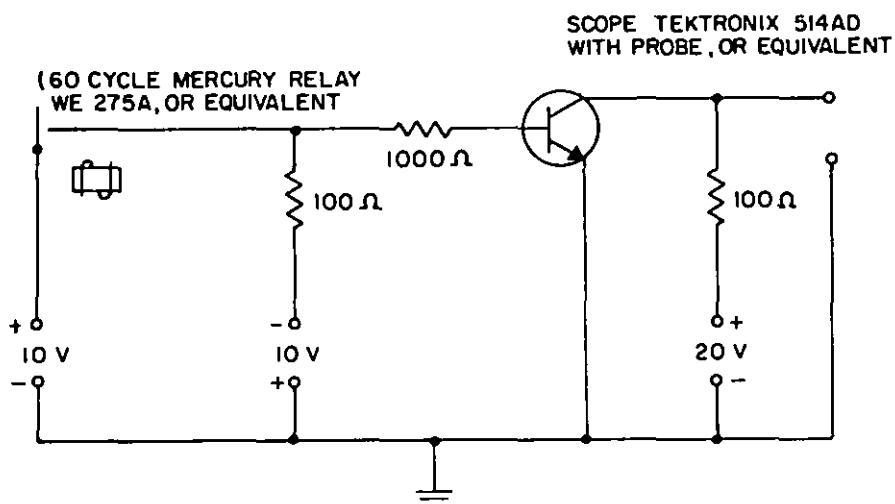


FIGURE 3. Switching time test circuit.

**Custodians:**

Army - EL  
Navy - EC  
Air Force - 85

**Review activities:**

Army - MU, MI  
Navy - SH  
Air Force - 11, 17  
DSA - ES

**User activities:**

Army - SM  
Navy - CG, MC, OS, AS  
Air Force - 13, 15, 19, 70, 80

**Preparing activity:**

Navy - EC

**Agent:**

DSA - ES

(Project 5961-0160)